



INL researchers studying the intersections between minds and machines are developing new digital control room displays that may be more intuitive for operators. The team tests their ideas in the new Human Systems Simulation Laboratory, a virtual nuclear control room.

## How to think like a nuclear control room operator

By Shannon Palus for *INL Communications & Governmental Affairs*

Some 10 shrill alarms were going off at once. The gauges indicated that the pressure in the pipes was still rising. In what looked and sounded like a nuclear plant control room, it appeared that there had been a steam generator tube rupture. Roger Lew and Thomas Ulrich — a pair of neuroscience graduate students at the University of Idaho — found themselves in charge of solving the problem.

Their focus ping-ponged from one dial-and-gauge-filled panel to another as a supervisor rattled off protocol from the middle of the room. Within minutes, the situation was under control. There would be no harmful leakage of radioactive water that day — not that they had anything to worry about since the scenario was merely a simulation of an extremely rare event.

Besides, the scene played out not in a real nuclear control room, but in the newly-erected Human Systems Simulation Lab (HSSL) at Idaho National Laboratory, supported by the U.S. Department of Energy Light Water Reactor Sustainability (LWRS) Program. The HSSL is a good facsimile of a real nuclear control room: The features of a real-life control room are loaded onto the HSSL's 45 large touch-screen panels, which are arranged vertically around the room. A computer on the other side of the room can simulate anything and everything that can go wrong.

This serves as a lab for Ulrich and Lew, as they do their summer research with the Human Factors group at INL — a team of researchers who study the intersections between minds and machines. Human factors, as a field, is applied to technology used by millions every day — iPhones, Facebook messenger, the turn signal lights in your car. These things are attractive and intuitive to the human mind by design. Human factors psychologists at INL are doing research that would make nuclear control rooms more attractive and intuitive, too. Along the way, they want to ensure that new technologies are at least as safe as older technologies.



**INL summer interns Thomas Ulrich, left, and Roger Lew are neuroscience graduate students at the University of Idaho.**

And now is a good moment to do so: Nuclear control rooms, along with their designs, have been around for more than 50 years. As wire insulation breaks down, and as alarm lights crack, they need to be replaced — and safety demands that things work smoothly.

The HSSL offers an interesting, perhaps obvious, solution: rather than just replace parts as they fail, find a way to design better parts. More sensible layouts. Alarms that make identifying problems easier. A system fit for the digital world. And designs should be based on the science behind the way people think.

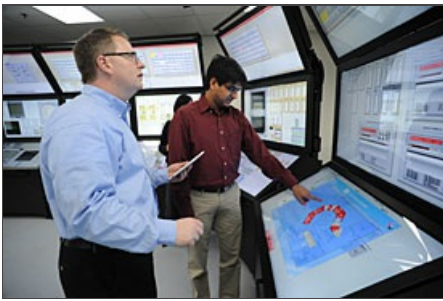
"The Human Systems Simulation Lab provides a test bed for nuclear reactor control room modifications that enables testing technologies that cannot practically be tested in our commercial reactor fleet," explains Kathy McCarthy, director of the Technical Integration Office for the LWRS Program. "This is an important part of the modernization activities supported by the (program)."

Ron Boring, principal investigator for the Pilot Project on Control Room Modernization, cites a need for fundamental psychological research on how people behave in control rooms. He and his interns are here to, as Lew explains, "take advantage of human perception to make things better."

To get inside the heads of control room operators, Ulrich and Lew spent days sifting through training manuals. They practiced the protocol for responding to a steam generator tube rupture, and other scenarios, over and over.

They examine traditional control-room setups to dream up improvements that take advantage of the human brain's natural tendencies.

For example, Lew is working on a digital Chemical Volume Control System panel. The display flips between a grid of water pressure readings and a visual diagram of the status of the valves. The



***Human factors researchers Ron Boring, left, and Vivek Agarwal test displays in the Human Systems Simulation Laboratory.***

design "co-locates" several readings that were previously at different places in the room. The new design could give operators an easy way to get an overview of a situation without requiring attention to ping-pong around the room so much.

Ulrich recently helped create an indicator display that is grey-colored when all is going well so that it fades into the background. When something goes awry, the indicator turns an eye-catching red.

The team will test new designs with actual operators to see if the upgrades are really improvements. There are cameras hung from the ceiling that can be used to observe operators and even track eye movements and reaction times.

If all goes well, the research supporting their digital display designs will be made available to anyone interested in designing a nuclear control room.

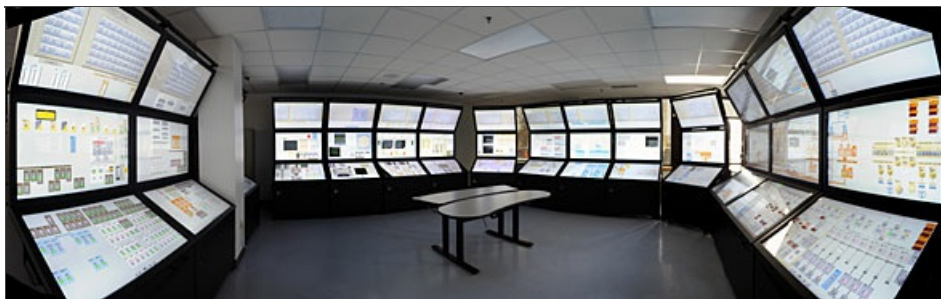
And with time, Lew's digital display and Ulrich's alarm prototypes will become part of the brains of control room operators, who have to know their surroundings at work as well as the backs of their own hands.

Asked if they would rather be working on something slicker and sexier, like Apple products, Lew and Ulrich say "no."

"It's nice to work on things that you know will be meaningful," says Lew. "I like the complexity of all of this."

Ulrich adds: "You get to see cool stuff that most people never think about."

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